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(71) Applicant:
USHIODENKI KABUSHIKI KAISHA
Chiyoda-ku, Tokyo (JP)

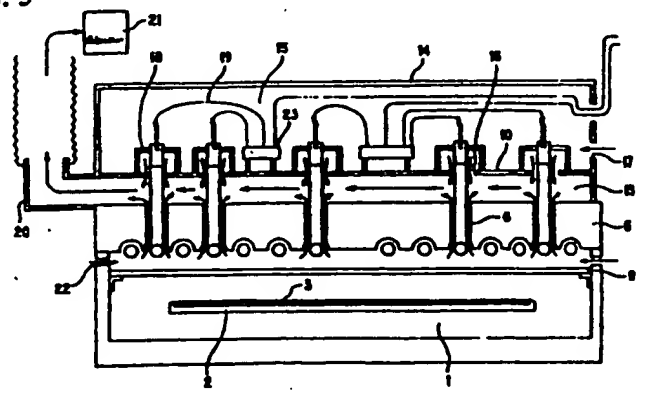
(72) Inventors:
- Suzuki, Shinji
Kawasaki-shi, Kanagawa-ken (JP)
- Minobe, Takashi
Yokohama-shi,Kanagawa-ken (JP)

(74) Representative:
Tomerius, Isabel, Dr. Dipl.-Chem. et al
Patentanwälte Weber & Helm,
Irmgardstrasse 3
81479 München (DE)

(54) Cooling arrangement of a heating device of the light irradiation type

(57) A cooling arrangement of a heating device of the light irradiation type in which, even when the wafer is heated to a high temperature of roughly 800 to 1200° C, the respective parts, such as the arc tube portion of the lamp, the insertion portion, the sealing area and the like can be easily controlled to a suitable temperature is achieved in a heating device of the light irradiation type, in which several lamps are disposed in a light irradiation chamber, each lamp having an arc tube portion, at least one insertion portion and at least one sealing area arranged on an at least one end of the arc tube portion, by the provision of a mirror which reflects the light from the arc tube portions behind the arc tube portions of the lamps and which has openings through which the insertion portions and the sealing areas pass; a cover chamber which has a plate with openings through which the sealing area of the lamps pass, and a cover with an opening for cooling air; and a wind box which is located between the plate of the cover chamber and the mirror and which is connected via a channel to an air mover, e.g., a blower, for drawing in or blowing in a cooling air flow. The air mover is connected to the opening for cooling air in the cover via the openings of the cover chamber plate, the wind box and the channel and being connected to the opening for cooling air in the light irradiation chamber via the openings of the mirror, the wind box and the channel.

FIG. 5



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this causes dilution and burning through of the filament 12. The service life of the filament 12 therefore becomes shorter. Since the vaporized halogen gas diminishes, the phenomenon occurs that the vaporized tungsten is deposed on the inner wall of the arc tube portion 7 without reaction with the halogen. When blackening occurs, the radiant energy from the filament 12 is absorbed by the blackened area. The wafer 3 can therefore no longer be irradiated with a stipulated energy. The insertion portion 8 must therefore have a temperature of at least equal to 250° C. Since the insertion portion 8 is an area which does not contribute to light irradiation of the wafer 3 and is not provided with an emission part of the filament 12, the temperature in this area often becomes low. It is therefore necessary to control the temperature of the insertion portion 8 to a suitable temperature.

4. The heat treatment device for the wafer 3 must heat the wafer to a temperature of 800 to 1200° C. Recently, an oxide layer has been produced in general at 1150° C. When the lamp 4 is operated using the device shown in Fig. 1, no cooling of the lamp 4 is accomplished. To keep the temperature of the bulb of the arc tube portion 7 of the lamp 4 less than or equal to 800° C, the maximum power per unit of length of the filament which can be supplied to the lamp 4 is 60 W/cm; this is not adequate for heating of the wafer 3 to 800 to 1200° C.

[0011] To eliminate the above described defect it can also be imagined that the lamp input power can be increased and cooling air blown onto the lamp 4 at the same time to cool it. However, here only the temperature of the area of the lamp 4 on which cooling air is blown (the side opposite the mirror 5) is reduced, it being difficult for the cooling air to penetrate into the gap between the mirror 5 and the lamp 4. Therefore, it is difficult to cool this area (the area opposite the mirror 5). Furthermore, in addition to temperature control of the arc tube portion 7, it is necessary to keep the sealing area 11 and the insertion portion 8 in the above described temperature range. As a result, in each part, there must be several temperature control devices, causing the disadvantage that the device has a complicated arrangement.

Summary of the Invention

[0012] The invention was devised to eliminate the above described disadvantages of the prior art. Therefore, a primary object of the present invention is to devise a cooling arrangement of a heating device of the light irradiation type in which, even when the wafer is heated to a high temperature of roughly 800 to 1200° C, the respective part, such as the arc tube portion of the lamp, the insertion portion, the sealing area and the like can be easily controlled to a suitable temperature.

[0013] This object is achieved in accordance with the present invention by a heating device of the light irradiation type in which several lamps are provided in a light irradiation chamber, each lamp consisting of an arc tube portion, insertion portions and sealing areas which ar each arranged on the ends of the arc tube portion, comprising the following:

- a mirror, which reflects the light from the arc tube portions, behind the arc tube portions of the lamps and which has openings through which the insertion portions and the sealing areas pass;
- a cover chamber which has a plate with openings through which the sealing area of the lamps pass, and a cover with an inlet opening for cooling air; and
- a wind box which is located between the plate of the cover chamber and the mirror, and which is connected via a channel to an evacuation means, the evacuation means being connected to the inlet opening for cooling air in the cover via the openings of the cover chamber plate, the wind box and the channel, and being connected to the inlet opening for cooling air in the light irradiation chamber via the openings of the mirror, the wind box and the channel.

[0014] The object is moreover advantageously achieved according to the invention in that the above described cover is provided with an inlet opening for cooling air in which the size of the opening can be changed.

[0015] In addition, the object is advantageously achieved in accordance with the invention by a heating device of the light irradiation type in which there are several lamps in the light irradiation chamber, the respective lamp consisting of an arc tube portion and insertion portions and sealing areas which are arranged each on the ends of the arc tube portion, comprising the following:

- a mirror which reflects the light from the arc tube portions behind the arc tube portions of the lamps and which has openings through which the insertion portions and the sealing areas pass;
- a cover chamber which has a plate with openings through which the sealing areas of the lamps pass, and a cover with an outlet opening for cooling air; and
- a wind box which is located between the plate of the cover chamber and mirror and which is connected via a channel to an air injection means, air being blown in by this air injection means via the channel, the wind box and the openings of the plate of the cooling air outlet opening of the cover, and air being blown in through the channel, the wind box, the openings of the mirror and the light irradiation chamber into the cooling air outlet opening of the

16 of the plate 10 the amount of cooling air in the sealing areas 11 can be controlled.

[0027] The measure that the fused silica glass window 9 is located between the lamps 4 and the wafer 3 can prevent the air flow due to the lamp cooling air from influencing the atmosphere in the vicinity of the wafer 3. Here, the inlet opening for the lamp cooling air 22 is located between the fused silica glass window 9 and the lamps 4.

[0028] This arrangement of the light source part of the device makes it possible to bring the temperature of the respective part of the lamp 4 to the desired temperatures even if the lamp is supplied with a power per unit of length of the filament from 80 to 120 W/cm and the wafer has been heated to 800 to 1200°C. This means that the surface temperature of the lamps can be cooled to a temperature of 800°C or less because the cooling air from the inlet opening 22 from the surfaces of the lamps 4 penetrates into the gap between the lamps 4 and the mirror 5 and cools all the arc tube portions 7 of the lamps 4.

[0029] This cooling air thus has a high temperature because heat has been taken from the lamp 4. Subsequent passage of this cooling air through the openings 6 and through the vicinity of the insertion portions 8 of the wind box 13 makes it possible to keep the temperature in the vicinity of the insertion portions 8 at least equal to 250° C. Therefore, shortening of the service life of the filaments 12 and blackening of the lamps 4 as a result of a drop in temperature of the insertion portions 8 can be prevented. If the size of the inlet opening 22 can be controlled, a suitable amount of air can be attained and the temperature of the arc tube portions 7 and of the insertion portions 8 of the lamps 4 can be easily controlled.

[0030] The sealing areas 11 can be cooled to 350°C or less by the measure that cooling air at room temperature penetrates from the cooling air inlet opening 17 in the cover 14 and cools the sealing areas 11. This cooling air which has cooled the sealing areas 11 passes through the openings 16 of the plate 10 and reaches the wind box 13. If the size of the inlet opening 17 of the cover 14 can be controlled, a suitable amount of cooling air can be attained and the temperature of the sealing areas 11 and of the insertion portions 8 of the lamps 4 can be easily controlled.

[0031] In the following, using Fig. 8 another embodiment of the invention will now be described. In the embodiment shown in Figs. 5-7, the evacuation means 21 is connected to the channel 20 which is connected to the wind box 13 and cooling is performed by evacuation. In the embodiment shown in Fig. 8, instead of the evacuation means 21 (blower), an air injection means 30 (compressed air feed means) is connected and cooling is performed by blowing in air. However, the remainder of the arrangement in this case is essentially identical to the arrangement in the embodiment shown in Figs. 5-7.

[0032] In the operation of lamps 4, the compressed air feed means 30 is operated and air is blown into the wind box 13. The air blown in by the compressed air feed means 30 passes through the channel 20 and passes as cooling air from the wind box 13 through the openings 6 which are penetrated by the insertion portions 8 of the lamps 4. The cooling air penetrates into the gap between the lamps 4 and the mirror 5, cools the lamps 4 and is evacuated to the outside (discharged) from the cooling air outlet opening 34 of the light irradiation chamber 1.

[0033] Furthermore, as shown in Fig. 8, in the mirror 5, in the vicinity of the arc tube portions 7 of the lamps 4 there are ventilation passages 31 which are several openings with a small diameter or which are slotted openings. Thus, the cooling air flows into the ventilation passages 31. The air blown into the wind box 13 passes as cooling air through the ventilation passages 31, is blown into the arc tube portions 7 of the lamps 4 and cools the lamps 4.

[0034] On the other hand, the air blown in from the compressed air feed means 30 passes from the wind box 13 through the openings 16 of the plate 10, cools the sealing areas 11 of the lamps 4, and is evacuated to the outside (discharged) also from the cooling air outlet opening 33 of the cover 14 of the cover chamber 15.

[0035] As in the above described embodiment, the size of the cooling air outlet opening 33 of the cover 14 of the cover chamber 15 is controlled in the manner described in Fig. 7, and thus, the amount of cooling air in the sealing areas 11 is controlled.

[0036] Even if cooling has been produced by blowing in air, the temperature of the respective part of the lamps 4 could be brought to the desired temperature as in cooling by drawing in air.

[0037] This means that the cooling air from the openings 6 penetrates from the surfaces of the lamps 4 into the gap between the lamps 4 and the minor 5, and cools all the arc tube portions 7 of the lamps 4. Furthermore, the cooling air is blown from the ventilation passages 31 into the arc tube portions 7 of the lamps 4 and thus cooling is produced. Therefore, the temperature of the lamp surface can be cooled to 800°C or below.

[0038] The temperature in the vicinity of the insertion portions 8 is controlled with consideration of the equilibrium between the heat as a result of heat conduction from the arc tube portions 7 and cooling by the cooling air and by controlling the amount of air blown in. Furthermore, the amount of cooling air can be controlled to a suitable amount of air by the fact that the size of the cooling air outlet opening 34 from which the cooling air is evacuated can be controlled.

[0039] Additionally, a cover 32 can be provided to prevent the insertion portions 8 from being directly affected by the cooling air, as is shown in Fig. 8, when the insertion portions 8 have been cooled to excess and the halogen cycle can no longer be maintained. In this way, the temperature in the vicinity of the insertion portions 8 can be kept at least equal to 250° C.

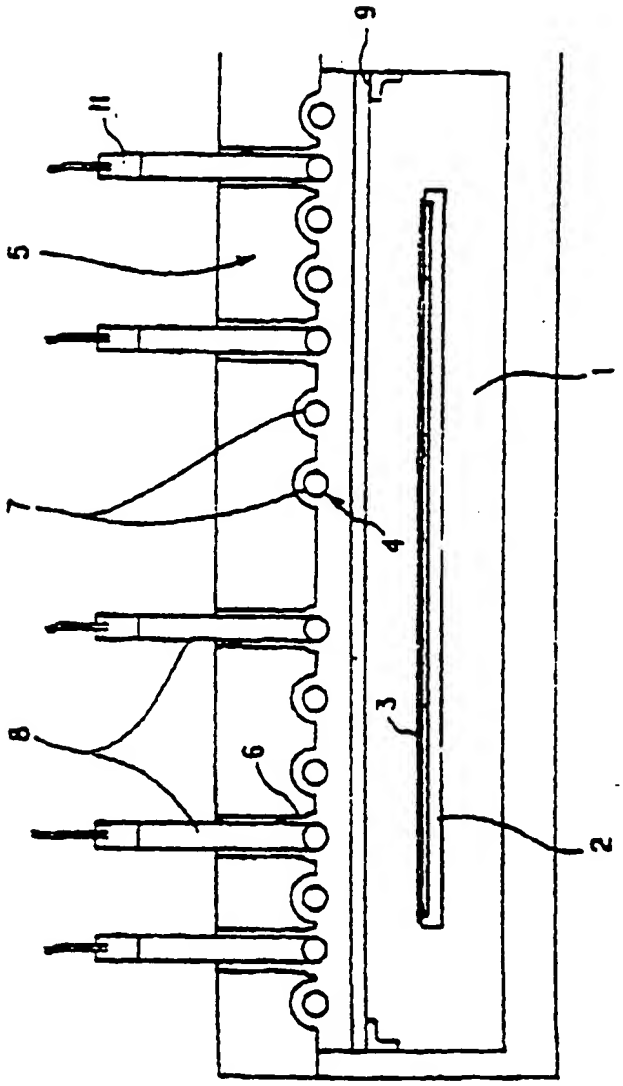
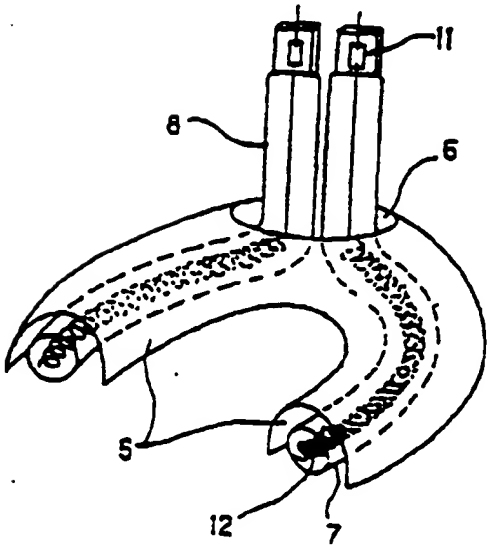


FIG. 1
(PRIOR ART)

FIG. 3
(PRIOR ART)



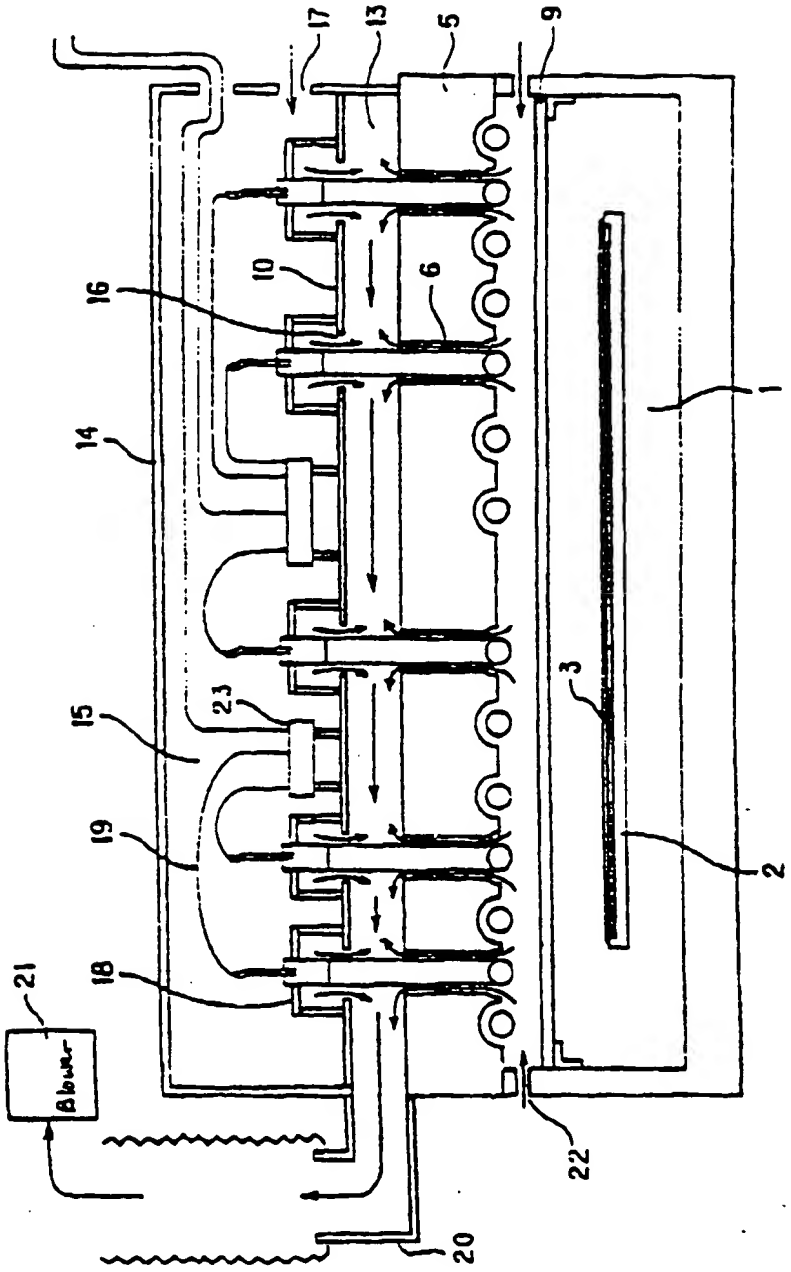


FIG. 5

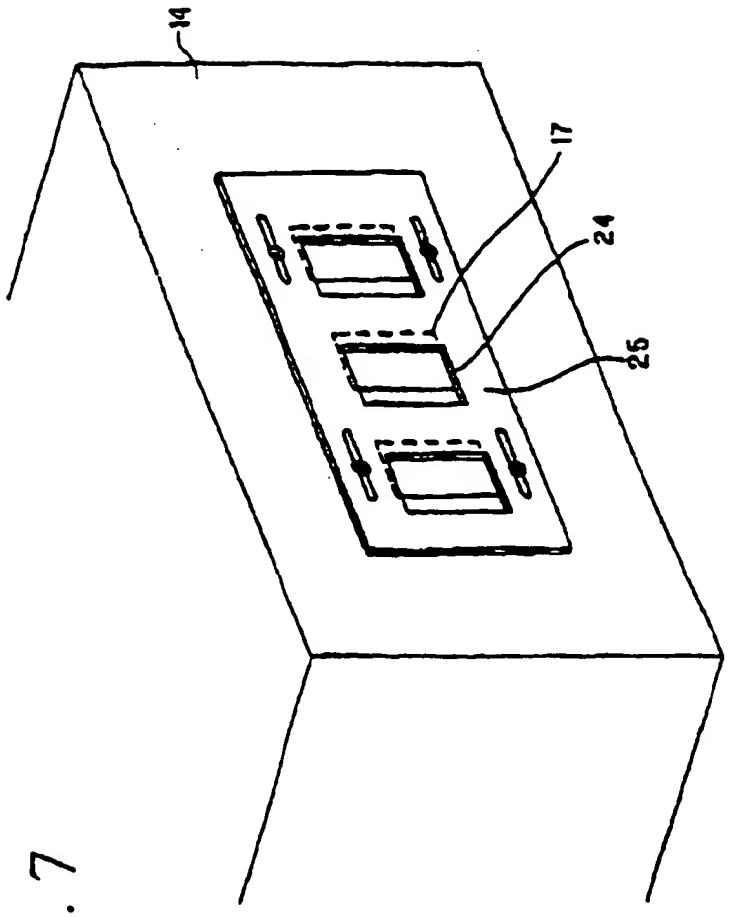


FIG. 7

FIG. 9